V.—*Contributions to the Pleistocene Flora of Canada.*[1]

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Since the author's first general summary of the Pleistocene flora of Canada, in 1890,[2] a number of additions have been made, which serve yet more fully to establish the similarity between the flora of that period and our own times. We have now to record other additions which serve to extend the geographical range over a much wider area.

PEAT AND LIGNITE FROM THE MOOSE AND MISSINAIBI RIVERS.

The material on which the first part of the present paper is based was collected by Dr. Robert Bell, of the Geological Survey, during the progress of his survey in the Moose River region, in the summer of 1895. As received by me, it was represented by four lots but only two kinds—coarse peat and lignite. These specimens are designated by laboratory numbers 44, 45, 46 and 47. Numbers 46 and 47 are lignite obtained from a locality on the Moose River about fifty miles from its mouth. Numbers 44 and 45 are specimens of coarse peat or vegetable matter derived from the foot of the Long Portage on the Missinaibi River, a stream which constitutes the western branch of the Moose River, reaching to within about twenty miles of the station of the same name on the Canadian Pacific Railway, but on the opposite side of the divide. Dr. Bell reports that this peat occurs in horizontal layers in a clayey deposit at a depth of fifty feet from the surface. For fully twenty years it has been known that lignite occurs in abundance on the Moose River and the tributary above mentioned. In 1865 Dr. Bell noted its occurrence, and in his report for the surveys of that year states that, in addition to its having been reported as seen *in situ* at the mouth of Coal Brook, fragments were to be found strewn, often in abundance, all along the bed of the Missinaibi River from the Forks to Coal Brook.[3] Similar lignites had previously been found on the Mattagami and Albany Rivers.[4] In 1867 Dr. Bell was able to observe this lignite *in situ* in several places on the Missinaibi River between the Long Portage and its junction with the Mattagami. At Coal Brook, three-fourths of a mile from its mouth, the deposit is about three feet thick. It is underlaid by soft, sticky blue clay, and

[1] In the preparation of this paper I am much indebted to Sir Wm. Dawson for a number of valuable suggestions relative to the geological aspects of the question.

[2] "On the Pleistocene Flora of Canada," Bull. Geol. Soc. Amer., i., 321.

[3] Geol. Surv. Can., 1875-76, 326.

[4] *Ibid.*, 1871-72, 112.

overlaid by about seventy feet of drift clay or "till," full of small pebbles and passing into gravel toward the top. Much of the lignite retains a distinctly woody nature, and some of the tree trunks are two feet in diameter. When dry it makes a good fuel, but contains a little iron pyrites. At a point nineteen miles below Coal Brook there is a deposit two and one-half feet thick, and again, nine miles above the Opazatika or Poplar River, there is a bed of shaly lignite six feet thick. Other deposits are to be found in various localities.[1] From this it is evident that this material occurs throughout an extended area of country.

The two specimens numbered 46 and 47 represent lignite of a dull black, having a somewhat lustrous fracture, but under the saw yielding a chocolate-brown surface. The transverse fracture gives no evidence of structure, but the radial fracture shows the medullary rays in a very prominent manner. Great difficulty was experienced in getting good sections of this material, since it would not yield to boiling, and its very friable character necessitated saturating it with balsam before it could be ground. In this way we finally succeeded in securing sections which, while far from satisfactory, gave enough to permit a study of all the details which the state of preservation would admit of recognition. The specimen represented by number 45 consisted of loose vegetable matter of a peaty character, but much broken up and suggesting either the action of water or the effect of rough handling. It readily yielded to the action of boiling water, through the influence of which the component vegetation was brought into a condition well adapted to study. Specimen 44 consists of broad, flaky masses, having a superficial area of about 9 square centimetres, and showing that considerable clay and sand is mingled with the much compacted vegetable matter. These flakes readily yielded to the action of boiling water, and, like the previous specimen, thereby became readily adapted to study. Between two of the large flakes of peat I found a splinter of wood 8 cm. long, 15 mm. wide, and 2 mm. thick through its central portion. This has been designated by laboratory number 44*a*. It readily yielded to the action of boiling carbonate of soda solution, and sections were then prepared by the paraffine method. From a detailed study of the material thus described, the following data have been obtained.

Larix americana.

The woody lignite described under numbers 46 and 47 was found to have been much compressed, and thereby greatly altered. This alteration had also been increased by the operation of decay, so that in transverse section nothing was recognizable beyond the demarcation of the growth-rings. Localized oval or rounded masses of resin were somewhat common, especially in number 47, and seemed to indicate the former

[1] Geol. Surv. Can., 1877-78, 4c.

positions of resin-passages. Radial sections show occasional resin-passages containing numerous round masses of resin, occasional badly disorganized bordered pits and numerous rather high medullary rays with resinous matter, and rather straight, thick-walled cells.

The tangential sections show numerous rather high, uni-seriate rays with thick-walled cells. Masses of resin are common.

These two specimens clearly represent the same kind of wood, and it is at once obvious, from the details given, that there are very few and unsatisfactory details upon which to base a differentiation. Nevertheless, the character of the rays at once points to the fact that the wood is either *Larix* or *Picea*, an indication greatly strengthened by the occurrence of resin-passages, from which the presence of fusiform rays may be inferred, although these structures are not obvious, owing to the effects of decay and compression. Nothing beyond this can be determined conclusively, but on geographical grounds we would be led to the inference that this species must be either *L. americana* or *P. nigra*. From this point of view, then, the somewhat highly resinous ray-cells would lead to the conclusion that the wood must be that of *Larix americana*, since in *Picea nigra* the rays are but slightly resinous, and the walls of the cells are much thinner.

Our present knowledge of the Pleistocene flora shows that this species was a somewhat prominent element, and had a wide distribution during that period, since it has also been found at Fort Madison, Iowa, and in New Brunswick. The distribution thus indicated conforms to the geographical range as we know it in existing representatives of this species.

Picea nigra.

The specimen designated 44*a* evidently represented a small branch which had become much flattened under pressure, in consequence of which the structure, as displayed in transverse section, was much distorted. Decay had also operated largely, so that only here and there was the structure found to be sufficiently preserved to permit of a recognition of details. From these it was possible to determine the following:

Transverse. Summer wood obscure. Spring tracheids large, thin-walled, squarish, but chiefly much distorted. Resin-passages rather abundant and sometimes perfectly preserved, without thyloses, but with thick-walled epithelium-cells, usually much distorted. Rays somewhat resinous.

Radial. Rays straight, thin-walled.

Tangential. Ordinary rays with thick-walled, oval or oblong cells. Fusiform rays with large resin-passages without thyloses, but with thick-walled epithelium.

These details point without much doubt to *Picea*, and most probably to *P. nigra*. Reference to previously determined localities show that this species also occurs in the Don Valley, Toronto,[1] at Hamilton, Ontario, and in the Leda clays at Montreal.[2] It is also to be observed that the occurrence of this wood together with *Larix americana* in the Pleistocene, is quite in accord with their occurrence within the same area of distribution at the present time.[3]

The external aspect of this specimen shows conclusively that it had been subject to the prolonged action of running water, and in the water-worn character of the surface we have one of the best of evidences that it represents drift material.

Distichium capillaceum.

The material represented by numbers 44 and 45 was found, upon boiling, to resolve itself chiefly into determinable mosses. The least common of these proved to be *Distichium capillaceum*. The fruit was entirely wanting, but the leafy stems were in the majority of cases remarkably well preserved, so that there was no difficulty in instituting a direct comparison with existing species. The locality where this material was found is well within the range of distribution of the species indicated, since specimens in the Herbarium of McGill University show that it is found in abundance at the mouth of the Moose River, and presumably, therefore, throughout the greater length of the river.

Hypnum recurvans.

By far the greater portion of the peaty masses already referred to consists of *Hypnum recurvans*. In this, as in the case of *Distichium*, the plants are remarkably well preserved, and it is possible to refer them to existing species without much difficulty, since the structure of the leaves is complete. The plants are, for the greater part, sufficiently large to show the characteristic branching of *Hypnum*, and although the fruit is altogether wanting, the leaf characters define the species clearly.

Lycopodium, sp.

Specimen 44 was found to contain a short section of a rhizome with roots attached. The structure was quite transparent through decay, and showed a distinct central vascular axis. The structure was clearly that of a lycopodiaceous plant, and in all probability the remains of a *Lycopodium*.

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[1] Journ. Geol., iii., 635.
[2] Can. Rec. Sc., vi., 353.
[3] Cat. Can. Plants, 1883, 468 and 475

UNDETERMINABLE MATERIAL.

While the body of the peat consists of the two species of mosses described, and chiefly of *Hypnum*, much fragmentary matter was separated out in boiling. Upon close examination this proved to consist principally of fragments of the leaves of mosses, together with much organic residue of an altogether indeterminate character. Short fragments of sedge leaves were also met with now and then, but they do not constitute any very prominent element. A very careful examination of the washings was made, in the hope of discovering spores or some other evidence of fructification, but the results were wholly negative in character. We are thus brought to the conclusion that the peat, as represented by the specimens examined, consists almost wholly of a deposit of *Hypnum*, with which a small quantity of *Distichium* is mingled.

In this connection the question naturally arises as to whether these plant remains represent material deposited in the place where it originally grew, or if it was displaced by the action of water and gradually accumulated where now found. With respect to the lignite, no satisfactory answer can be given. The peat, on the other hand, affords conclusive evidence on this point. It has already been shown that the peat occurs in the form of consolidated flakes. These masses show upon examination that the component vegetation has been felted together in such a way as would be possible only through the action of water. In addition to this, there is much mingled sand and clay, which is also deposited between the flakes, while it has already been shown that the bits of wood inclosed in the peat are drift material. If further evidence were needed, it could be obtained from the known habits of growth of the plants represented. Thus we find that *Distichium capillaceum* grows in the fissures of rocks and similar situations, from which it must have been dislodged through the action of water. *Hypnum recurvans* is very common in mountainous districts, where it is found growing upon decaying trees and logs, and its accumulation in such quantity as is represented in this peat can only be explained upon the ground that it was gradually carried down to lower levels by the continued washings of spring freshets. It is thus evident that all of this material must have been derived from localities much nearer the head-waters of the Missinaibi than represented by its present position, and thus it had its origin in somewhat more southern localities. Both of the mosses found, however, are of a northern type, and at the present time are distributed within the same general area, so that they afford no special evidence of climate beyond that already derived from the other forms of plants observed.

NODULES FROM BESSERER'S WHARF.

During the last five years Dr. Ami and Mr. Lamb, of the Geological Survey, have collected a number of Pleistocene fossils from a locality known as Besserer's wharf, on the shore of the Ottawa River, about fourteen miles below the city of Ottawa. The formation at that point is Leda clay, and the fossils are contained in nodules as in the case of those from Green's Creek. With one or two exceptions, all the nodules contain plant remains. The facts indicated, joined to the identical character of the plants, would seem to justify the belief that these two localities belong to the same deposit, a belief which is greatly strengthened by their close proximity.

With the present extension of our knowledge of the Leda clay vegetation, it is possible to add a few new species, and to confirm previous determinations of plants from Green's Creek, about which there was a certain element of doubt. The following is a summary of the facts derived from a study of these nodules.

Typha latifolia?

Not previously recorded. The only representation of this plant was found in a fragment of an endogenous stem 18 mm. broad, completely flattened and showing thin films of carbonized cortical structure. The surface markings are such as to justify provisional reference to the species indicated.

Populus balsamifera.

The only locality for this plant heretofore reported is Green's Creek. It occurs in the nodules from Besserer's quite frequently, although in fragments only.

Vallisneria, sp.

The only locality for this plant previously reported, is Rolling River, Manitoba. Similar leaves have now been found in abundance in the nodules from Besserer's wharf. As in all these cases only fragments of leaves are to be met with, and there is no connection with stems, the determination involves an element of considerable doubt, more particularly when it is recalled that all these nodules contain undoubted *Potamogeton* stems, and that the leaves under consideration may, therefore, belong to *P. zosterifolius*, a species which is even now common in the vicinity of Ottawa, and which is very likely to occur in these nodules. *Vallisneria* is also common in the vicinity of Ottawa at the present time, so that there is quite as much probability that it may also be present in the nodules, and under these circumstances the determination may be

allowed to stand provisionally, subject to the confirmation of future research.

Hypnum fluitans.

Several fragments of the leafy stems of a moss, usually about 18–20 mm. long, were encountered. These were found to be comparable with *H. fluitans* of Linnæus, and are therefore referred to that species. This species, which is at present a widely distributed one, is now found in the vicinity of Ottawa in McKay's woods. (*Macoun.*)

Cyperaceæ.

In several of the nodules were small seed-like bodies about 1 mm. broad. In one instance the seed was split open, showing the inner face of a hard and light-coloured testa or pericarp. It was at first surmised that it might represent the fruit of a *Potamogeton*, but a careful comparison with the fruit of recent specimens showed that this could not be, and for the present their true affinity must remain a matter of conjecture only. In another instance a carbonized seed or fruit was found to be distinctly of the external aspect of a cyperaceous fruit, and we may therefore refer all such bodies to this family provisionally.

In addition to these fruits, all the nodules contained more or less numerous fragments of what appeared to be the leaves of sedges, and for want of more exact differential data they may be provisionally referred to the *Cyperaceæ*.

Potamogeton perfoliatus.

This species, represented by several leaf fragments, has already been obtained from the Green's Creek nodules.

Potamogeton rutilans.

In the previous description of the Green's Creek fossils this species was announced provisionally. In the nodules from Besserer's a number of plants of the same description have been met with, and in a much better state of preservation, some of the specimens being small plants about six to eight centimetres high, and showing the root system fairly well. It is thus possible to assign them with some degree of confidence to the species above indicated.

Potamogeton pusillus.

This species, already reported from Green's Creek, is found in abundance in the nodules from Besserer's wharf. They are represented by both leaves and stems in a fairly well preserved state. Many of the nodules show short, oblong or round bodies of a composite character, the true nature of which remained in doubt for some time. They usually measure 1 × 3 mm., and are sometimes presented in side view, or again

in end view, and are therefore either oblong or round. The interior exhibits a number of small cavities, showing the decay of structures originally present. A more extended examination led to the conclusion that these bodies represent the inflorescence in a bud condition, or the fruit of one of the plants otherwise represented. In a few instances they were found attached to stems which were undoubtedly those of a *Potamogeton*. Comparison with the inflorescence of recent species of this genus show that they bear a very close resemblance to the flowering spikes of both *P. pauciflorus* and *P. pusillus*. As the resemblance to the latter is very close both in point of size and external appearance, and as this species has already been determined to be present, I feel that there need be no hesitation in referring these structures to it.

Potamogeton pectinatus.

This species, at present widely distributed throughout Canada, is represented in the nodules from Besserer's by leaves and also by one specimen of the young inflorescence. The latter shows a young spike terminal to the main stem before elongation of the peduncle, and central to two leaves. The dimensions, as well as the whole aspect of the specimen, agree admirably with herbarium specimens of the species above indicated.

Equisetum limosum.

A small portion of the silicified epidermis of an *Equisetum*, either *E. limosum* or *E. hymale*. The former has already been found at Green's Creek, and the present specimen is therefore referred to that species.

Betula lutea?

Represented in one case only by a portion of a leaf. The specimen is most nearly comparable with *Betula lutea*, to which it is referred provisionally. This is the first record for this plant, a species which is at the present time common, throughout Ontario and eastern Canada.

Potentilla anserina.

This plant was found at Green's Creek some years since, and now appears in the nodules at Besserer's with considerable frequency. It is quite likely that many of the exogenous stems which so frequently occur in these nodules in the form of undeterminable fragments may belong to this species.

Fucus digitatus, n. sp.

A *Fucus* has already been reported as occurring in the nodules from Green's Creek, and in the Leda clays at Besserer's the same plant appears in greater abundance and of larger size. In the original account of it, I indicated that it could not be satisfactorily referred to any of our exist-

ing species, and suggested that *digitatus* would be a satisfactory specific name. In its general aspect this plant resembles *F. evanescens*, but is much smaller, and as the fruit is in all cases wanting, it is difficult to assign it to any modern species. The name of *F. digitatus*, as suggested, may, under these circumstances, be applied provisionally.

PLANTS FROM OTHER LOCALITIES.

In addition to the material from the Moose and Missinaibi Rivers, and from Besserer's wharf, as described, a number of new localities, as well as several additional plants, have been brought to notice within the last few years, and it will be profitable to consider these in connection with the data already recorded, in order to gain some clearer conception of their climatic and geological relations.

LARIX AMERICANA.

Our first enumeration of Pleistocene plants shows that this species had already been found by Mr. Weston in the Leda clays at Montreal.[1] Two more localities are now to be recorded. The first was reported by Mr. C. S. Gordon, of Chicago University, from the lower Till at Fort Madison, Iowa. The second was reported by Dr. W. F. Ganong, of Smith College, Northampton, Mass., from peat bogs in New Brunswick.[2] The first locality represents a region which is at or possibly just beyond the extreme southern limit of distribution for the species at the present time. The second locality lies within the southern area of distribution, but within an area where the species is at present common.

TAXUS CANADENSIS.

This species has already been reported from five different and widely separated localities.[3] More recent material confirms the previous determination of its occurrence in the Don valley at Toronto, and indicates a new locality in the lower Till at Fort Madison, Iowa. The distribution thus indicated, accords fully with the present distribution of the species.

PINUS STROBUS.

No previous record of this species has been made, but material submitted to me during the autumn of 1895 showed remarkably well preserved specimens of this wood from peat bogs in New Brunswick.[2]

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[1] Bull. Geol. Soc. Amer., i., 334.

[2] These specimens were derived from deep down in peat bogs, and although it is quite likely that they belong to more recent deposits, there is a possibility that they may be Pleistocene. They are, therefore, stated in this connection provisionally.

[3] Bull. Geol. Soc. Amer., i., 320; Amer. Geol., xiii., 94.

Platanus occidentalis.

A specimen of this wood was sent to me by Prof. A. P. Coleman, of Toronto, in 1893. It had been obtained a few years previously by Mr. Spry, C.E., from a locality east of the Don River, near Jail Hill. It was found at a depth of thirty or forty feet below the surface, and formed part of a trunk nineteen inches in diameter. Upon examination the structure was found to be much compressed, and by reason of this fact, joined to somewhat extensive decay, many of the details of structure were lost. It was, however, possible to refer the wood without much doubt to *Platanus occidentalis*.

Ulmus americana.

Although *Ulmus racemosa* has already been recorded from the Don,[1] this is the first instance of *U. americana* having been found.[2] It was obtained by Prof. Coleman of Toronto, from the Don valley, at what he has designated "Convicts' Cutting." The material is well preserved, and readily admits of reference to the species indicated.

Picea sitchensis.

A badly decayed specimen of wood from "Convicts' Cutting," near Toronto. The structure is so badly disorganized as to make reference to the species a matter of much doubt. The wood is undoubtedly a *Picea*, and appears to approach closely to *P. sitchensis*,[3] but this view can only be accepted as a provisional one, and in determining the probable climate of the region should not be taken into consideration.

Fraxinus quadrangulata (?).

The only specimen of this wood so far recorded was obtained from the Interglacial of the Don, in 1893, by Prof. Coleman, of Toronto.[4] The structure of the wood was found to be greatly altered, so that while the generic characters could be ascertained without difficulty, the species was a matter of considerable doubt. It was, however, referred to *F. quadrangulata* as the nearest of existing species.

Quercus obtusiloba.

The only oak so far recorded from the Pleistocene was obtained by Prof. Coleman from the same locality as the last species.[5] The structure had suffered great alteration, and the species could not be ascertained with certainty, but it has been referred provisionally to the nearest exist-

[1] Bull. Geol. Soc. Amer., i., 323.
[2] Journ. Geol., iii., 635.
[3] *Ibid.*, iii., 635.
[4] Amer. Geol., xiii., 94; Journ. Geol., iii., 635.
[5] *Ibid.*, xiii, 95; *Ibid.*, iii., 635.

ing species. *Q. obtusiloba* is now found in southern Ontario, and particularly about the Bay of Quinté. (*Macoun.*)

MACLURA AURANTIACA.

The most interesting of all the specimens derived from the Interglacial is the osage orange. Well preserved specimens of the wood of this plant were sent to me in 1895 by Prof. Coleman,[1] and by him obtained from the Don valley at Jail Hill. It thus belongs to the same period as *Quercus obtusiloba* and *Fraxinus quadrangulata*. This plant is of a more distinctly southern type than any of the others, and it therefore possesses peculiar interest as indicating the climatic conditions which must have prevailed at the time the Interglacial of the Don was laid down. At the present time the osage orange is chiefly found ranging from Kansas and Missouri to Texas. It nevertheless is sparingly found in Ontario at the present time. Sir Wm. Dawson informs me that in former years he has had specimens of the wild osage from that region. It is certainly cultivated there for hedges, and Prof. Macoun is inclined to consider that the wild plants are escapes.

LARIX CHURCHBRIDGENSIS.

Two specimens of wood were described by me in 1892 under the above name.[2] The material was forwarded to me by Mr. J. B. Tyrrell, of the Geological Survey, and had been derived from two localities in Manitoba. The horizon at which these woods were found is probably Interglacial, although this view must be regarded as somewhat provisional. Both specimens clearly represented the same species, which was found to possess characters common to both *Larix occidentalis* and *L. americana*. It was, therefore, thought desirable to refer them to a provisional species the name of which would be indicative of the locality.

In addition to the material received from the Don valley, and described as above, there were a number of fragments of leaves which were too much broken up to admit of satisfactory determination. They were, nevertheless, in all probability those of willows and poplars.[3]

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[1] Journ. Geol., iii., 635.
[2] Amer. Geol., ix., 368.
[3] Journ. Geol., iii., 635.

The following synopsis of all the species of Pleistocene plants, so far obtained from Canadian localities, will serve to convey a more adequate idea of the extent of this flora and the details of its distribution :

1. *Abies balsamea*, Mill.
   Scarboro Heights, Ontario (Coleman).
   Jn'l of Geol. III., 625.
2. *Acer pleistocenicum*, Pen.
   Don River, Toronto (Townsend).
   Bull. Geol. Soc. Amer. I., 327.
3. *Acer saccharinum*, Wang.
   In nodules from Green's Creek, Ottawa (Sir Wm. Dawson).
   Bull. Geol. Soc. Amer. I., 329, 333 : Can. Nat., N. Ser., III., 71 ; VI., 403.
4. *Algæ*, not determinable.
   Green's Creek nodules, Ottawa, and Leda clays, Montreal (Sir William Dawson).
   Can. Nat., N. Ser. III., 75 ; Can. Nat. II., 422.
5. *Alnus*, sp.
   Scarboro Heights, Ontario (Coleman).
   Jn'l of Geol. III., 626.
6. *Asimina triloba*, Dunal.
   Don Valley, Jail Hill, Toronto (Townsend).
   Bull. Geol. Soc. Amer. I, 323, 333 : Jn'l of Geol. III., 636.
7. *Betula lutea*, Michx. f.
   Besserer's Wharf, Ottawa River (Ami).
8. *Brasenia peltata*, Pursh.
   In nodules from Green's Creek, Ottawa (Miller).
   Bull. Geol. Soc. Amer. I., 326, 333.
9. *Bromus ciliatus*, L.
   In nodules from Green's Creek, Ottawa (Miller).
   Bull. Geol. Soc. Amer. I., 334.
10. *Cyperaceae*, not determinable.
    Green's Creek, Ottawa (Sir William Dawson) ; Besserer's Wharf, Ottawa River (Ami).
    Can. Nat., N. Ser. VI., 404.
11. *Carex aquatilis*, Whal.
    Scarboro Heights, Ontario (Coleman).
    Jn'l of Geol. III., 626.
12. *Carex Magellanica*, Lamarck.
    In nodules from Green's Creek, Ottawa (Miller & Stewart).
    Bull. Geol. Soc. Amer. I., 325, 334.
13. *Carex utriculata*, Boot.
    Scarboro Heights, Ontario (Coleman).
    Jn'l of Geol. III., 626.
14. *Cocconeis*, sp.
    Rolling River, Manitoba (Tyrrell).
    Bull. Geol. Soc. Amer. I., 334.
15. *Cornus*, sp.
    Greenville, N.J. (Edwards).
16. *Distichium capillaceum*, Bruch. & Schimp.
    Foot of the Long Portage, Missinaibi River (Bell).
17. *Drosera rotundifolia*, L.
    In nodules from Green's Creek, Ottawa (Sir Wm. Dawson).
    Bull. Geol. Soc. Amer. I., 329, 333 : Can. Nat., N. Ser. III., 70 ; VI., 405.
18. *Elodea canadensis*, Michx.
    Rolling River, Manitoba (Tyrrell).
    Bull. Geol. Soc. Amer. I., 325, 334.

19. *Encyonema prostratum*, Ralfs.
Rolling River, Manitoba (Tyrrell).
Bull. Geol. Soc. Amer. I., 334.

20. *Equisetum limosum*, L.
In nodules from Green's Creek, Ottawa (Stewart), and Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 327, 334.

21. *Equisetum scirpoides*, Michx.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson).
Bull. Geol. Soc. Amer. I., 331, 334 : Can. Nat., N. Ser. III., 331, 334; VI., 404.

22. *Equisetum*, sp.
Scarboro Heights, Ontario (Coleman).
Jn'l of Geol. III., 626.

23. *Equisetum sylvaticum ?* L.
In nodules from Green's Creek, Ottawa (Stewart).
Bull. Geol. Soc. Amer. I., 334.

24. *Fontinalis*, sp.
In nodules from Green's Creek, Ottawa (Sir William Dawson); Scarboro Heights, Ontario (Hinde).
Bull. Geol. Soc. Amer. I., 333, 334 : Jn'l of Geol. III., 625 : Can. Jn'l, 1878, 399 : Can. Nat., N. Ser. III., 73 ; VI., 404.

25. *Fucus digitatus*, Pen.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson) and Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 332, 334 : Can. Nat. II., 422 : Can. Nat., N. Ser. III., 73 ; VI., 404.

26. *Fraxinus quadrangulata*, Michx.
Don. Valley, Toronto (Coleman).
Amer. Geol. XIII., 94 : Jn'l of Geol. III., 635.

27. *Gaylussacia resinosa*, Torr. & Gray.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson).
Bull. Geol. Soc. Amer. I., 331, 333 : Can. Nat., N. Ser. III., 71 ; VI., 403.

28. *Gramineae*, not determinable.
Green's Creek nodules (Sir Wm. Dawson).
Can. Nat., N. Ser. VI., 404.

29. *Hypnum commutatum*, Hedw.
Scarboro Heights, Ontario (Hinde).
Jn'l of Geol. III., 625 : Can. Jn'l, 1887, 399.

30. *Hypnum fluitans*, L.
Besserer's Wharf, Ottawa River (Ami).

31. *Hypnum recurvans*, Schwaeger.
From the foot of the Long Portage, Missinaibi River (Bell).

32. *Hypnum revolvens ?* Swartz.
Scarboro Heights, Ontario (Hinde).
Can. Jn'l, 1887, 399 : Jn'l of Geol. III., 625.

33. *Larix americana*, Michx.
Moose River (Bell); Leda clays, Montreal (Weston); Lower Till, Fort Madison, Iowa (Gordon); Peat bogs, New Brunswick (Ganong); Scarboro Heights, Ontario (Macoun).
Jn'l of Geol. III., 626 : Bull. Geol. Soc. Amer. I., 326, 334.

34. *Larix churchbridgensis*, Pen.
Churchbridge, Manitoba (Tyrrell); Sec. 23, Township 3, Range II., Manitoba (Elliott).

35. *Licmophora*, sp.
Rolling River, Manitoba (Tyrrell).
Bull. Geol. Soc. Amer. I., 334.

36. *Lycopodium*, sp.
Foot of the Long Portage, Missinaibi River (Bell); Scarboro Heights, Ontario (Hinde).
Jn'l of Geol. III., 625: Can. Jn'l, 1887, 399.

37. *Maclura aurantiaca*, Nutt.
Don Valley, Toronto (Coleman).
Jn'l of Geol. III., 635.

38. *Menyanthes trifoliata*, L.
Leda clays, Montreal (Sir Wm. Dawson).
Bull. Geol. Soc. Amer. I., 327, 333.

39. *Navicula lata*, Breb.
Rolling River, Manitoba (Tyrrell).
Bull. Geol. Soc. Amer. I., 334.

40. *Oryzopsis asperifolia*, Michx.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson).
Bull. Geol. Soc. Amer. I., 331, 334.

41. *Oxycoccus palustris*, Pers.
Scarboro Heights, Ontario (Coleman).

42. *Picea alba*, Link.
Bloomington, Ill. (Andrews).
Bull. Geol. Soc. Amer. I., 333, 334.

43. *Picea nigra*, Link.
Leda clays, Montreal (Sir Wm. Dawson); Don Valley, Toronto (Coleman); Erie clays, Hamilton, Ontario (Dr. G. M. Dawson); Missinaibi River (Bell).
Can. Rec. Sc. VI., 353.

44. *Picea sitchensis?* Trautv.
Don Valley, Toronto (Coleman).
Jn'l of Geol. III., 635.

45. *Pinus strobus*, L.
Peat Bogs, New Brunswick (Ganong).

46. *Platanus occidentalis*, L.
Don Valley, Toronto (Coleman).

47. *Populus balsamifera*, L.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson) and Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 331, 333: Can. Nat., N. Ser. III., 72; VI. 403.

48. *Populus grandidentata*, Michx.
Leda clays, Montreal (Weston); Green's Creek nodules, Ottawa (Stewart).
Bull. Geo. Soc. Amer. I., 326, 334.

49. *Potamogeton pectinatus*, L.
Besserer's Wharf, Ottawa River (Ami).

50. *Potamogeton perfoliatus*, L.
In nodules from Green's Creek, Ottawa (Sir Wm. Dawson) and Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 331, 334: Can. Nat., N. Ser. III., 72; VI., 404.

51. *Potamogeton pusillus*, L.
In nodules from Green's Creek, Ottawa (Sir William Dawson); Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 331, 334: Can. Rec. Sc. III., 74.

52. *Potamogeton rutilans*, Wolfg.
In nodules from Green's Creek, Ottawa (Stewart); Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 327, 334.

53. *Potentilla anserina*, L.
From Green's Creek, Ottawa (Sir Wm. Dawson and Miller) and Besserer's Wharf, Ottawa River (Ami).
Can. Nat., N. Ser. III., 71 ; VI., 403 : Bull. Geol. Soc. Amer. I., 330, 333.

54. *Quercus obtusiloba*, Michx.
Don Valley, Toronto (Coleman).
Amer. Geol. XIII., 95 : Jn'l of Geol. III., 635.

55. *Salix*, sp.
Scarboro Heights, Ontario (Coleman) ; Don Valley, Toronto (Coleman).
Jn'l of Geol. III., 626, 635.

56. *Taxus canadensis*, Willd.
Don River, Toronto (Townsend) ; Solsgirth, Manitoba (Dr. G. M. Dawson & Tyrrell) ; Rolling River, Manitoba (Tyrrell) ; Cape Breton (Sir Wm. Dawson) ; Bloomington, Ill. (Andrews) ; Don Valley, Toronto) Coleman) ; Lower Till. Fort Madison, Iowa (Gordon).
Bull. Geol. Soc. Amer. I., 321, 334 : Amer. Geol. XIII., 94 : Jn'l of Geol. III., 636 : Trans. R. Soc. Can. IV., iv., 92.

57. *Thuya occidentalis*, L.
Leda clays, Montreal (Sir Wm. Dawson) ; Leda River, Manitoba (Dr. G. M. Dawson) ; Marietta, Ohio (Newberry).
Bull. Geol. Soc. Amer. I., 324, 334 : Can. Nat. II., 422 : Can. Nat., N. Ser. III., 72 ; VI., 404.

58. *Cupressus thyoides*, L.
Greenville, N.J. (Edwards).

59. *Typha latifolia* L.
Besserer's Wharf, Ottawa River (Ami).

60. *Ulmus americana*, L.
Don Valley, Toronto (Coleman).
Jn'l of Geol. III., 635 : Bull. Geol. Soc. Amer. I., 323.

61. *Ulmus racemosa*, Thomas.
Below Erie clays, Don River, Toronto (Townsend).
Bull. Geol. Soc. Amer. I., 323, 333.

62. *Vaccinium uliginosum*, L.
Scarboro Heights, Ontario (Coleman).
Jn'l of Geol. III., 626.

63. *Vallisneria*, sp.
Rolling River, Manitoba (Tyrrell) ; Besserer's Wharf, Ottawa River (Ami).
Bull. Geol. Soc. Amer. I., 325, 334.

If we next consider these plants comparatively, according to the six principal localities from which they have been derived, it will be possible to gain some further conception of their bearing upon climatic conditions :

Don River.	Leda Clays.			Scarboro.	Moose River.
	Green's Creek.	Besserer's.	Montreal.		
				Abies balsamea.	
Acer pleistocenicum.					
	Acer saccharinum.				
	Algae, sp.		*Algae*, sp.		
				Alnus, sp.	
Asimina triloba.					
		Betula lutea.			
	Brasenia peltata.				
	Bromus ciliatus.				
	Cyperaceae.	*Cyperaceae.*			
				Carex aquatilis.	
	Carex Magellanica.				
				Carex utriculata.	
					Distichium capillaceum.
	Drosera rotundifolia.				
	Equisetum limosum.	*Equisetum limosum.*			
	Equisetum scirpoides.				
				Equisetum, sp.	
	Equisetum sylvaticum.				
	Fontinalis? sp.			*Fontinalis*, sp.	
	Fucus digitatus.	*Fucus digitatus.*			
Fraxinus quadrangulata.					
	Gaylussacia resinosa.				
	Gramineæ, sp.				
		Hypnum fluitans.			
				Hypnum commutatum.	

TABLE OF COMPARISONS.—*Continued.*

DON RIVER.	LEDA CLAYS.			SCARBORO.	MOOSE RIVER.
	GREEN'S CREEK.	BESSERER'S.	MONTREAL.		
					Hypnum recurvens.
				Hypnum revolvens.	
			Larix americana.	*Larix americana.*	*Larix americana.*
				Lycopodium, sp.	*Lycopodium* sp.
Maclura aurantiaca.					
			Menyanthes trifoliata.		
	Oryzopsis asperifolia.				
				Oxycoccus palustris.	
Picea nigra.			*Picea nigra*		*Picea nigra.*
Picea sitchensis.					
Platanus occidentalis.					
	Populus balsamifera.	*Populus balsamifera.*			
	Populus grandidentata.		*Populus grandidentata.*		
		Potamogeton pectinatus.			
	Potamogeton perfoliatus.	*Potamogeton perfoliatus.*			
	Potamogeton pusillus.	*Potamogeton pusillus.*			
	Potamogeton rutilans.	*Potamogeton rutilans.*			
	Potentilla anserina.	*Potentilla anserina.*			
Quercus obtusiloba.					
Salix, sp.				*Salix*, sp.	
Taxus canadensis.					
			Thuya occidentalis.		
		Typha latifolia.			
Ulmus americana.					
Ulmus racemosa.					
		Vallisneria, sp.			
				Vaccinium uliginosum	

A careful examination of the foregoing tables will serve to disclose important facts relative to the nature of the climate which distinguished the several periods indicated. The vegetation of the Don River period is very remarkable in the testimony it affords as to a warmer climate. Of the range of *Acer pleistocenicum* we know nothing, since it is impossible at the present time to establish its proper affinity with any given existing species. *Picea sitchensis* is a determination of doubtful value, and, as already pointed out, this species must be left out of consideration in determining climatic conditions. *Salix* must also be left out of consideration, since we do not know the species, and thus are unable to decide whether it represents northern or southern types. *Taxus canadensis* is a species which to-day ranges as far south as New Jersey, and much farther north than the Don River, so that it may have formed an element of a climate the same as now, or have grown in a climate either warmer or colder. *Ulmus racemosa* ranges southward to Missouri and Kentucky, and its occurrence in Ontario brings it to the northern limit of distribution, so that it must be regarded as a southern type. *Ulmus americana*, although a more northern type than the preceding, is nevertheless chiefly found to the south of the Don, so that its occurrence in the region of Toronto, brings it pretty well towards the northern limit of its range. *Quercus obtusiloba* is a distinctly southern type, having its highest northern limits in Michigan, and reaching southward to Florida and Texas, becoming more abundant in the southern portion of its area of distribution. *Platanus occidentalis* is also a southern type, having its highest northern limits in Canada in the valley of the Don, thence extending southward through the United States. *Picea nigra* like *Taxus canadensis*, is a type of plant which may have belonged to a climate either warmer or colder than that of Toronto, at the present day. It is found as far south as Pennsylvania, and reaches far northward to the Arctic Ocean. It is, therefore, an Arctic type, but of such a character than it may have formed an element in the flora of a somewhat warmer climate than that of Ontario. *Maclura aurantiaca* is now found sparingly in southern Ontario, and at least may be cultivated there. It is, nevertheless, a southern type, since it is now found chiefly through the region from eastern Kansas to northern Texas; the evidence which it affords, is thus of exceptional value. *Fraxinus quadrangulata* in southern Ontario is also at its northern limit of distribution, extending southward as far as Tennessee. *Asimina triloba* is rare in Ontario, being found at only a few places along the shores of Lake Erie. It is a southern type.

Our enumeration thus shows that there are nine species of plants occurring in the Pleistocene of the Don, of which six, or sixty-six per cent are distinctively of a more southern type than the vegetation at present flourishing in the same region, while three, or thirty-three per cent may readily have flourished in a climate as warm as that of New

Jersey or Pennsylvania. From the standpoint of botanical evidence, therefore, the testimony points conclusively to the fact that the climate of the Don period must have been much warmer than now, and in all probability similar to that of the Middle United States.

The plants of Green's Creek, Scarboro Heights, Moose River, Besserer's and Montreal are different from the above and constitute a distinct group, probably, also, of different age. They are essentially of the same character from all these localities, and represent a vegetation which is, without exception, the same as that which now flourishes through the same region. They indicate beyond doubt, a climate similar to that of our own time or possibly a little more severe.

In reviewing the evidences of climate afforded by the plants derived from the Leda clays, Montreal, and from the nodules of Green's Creek, Ottawa, I find that Sir Wm. Dawson expressed a similar opinion as long ago as 1868, holding that the plants derived from the latter locality must represent the vegetation of the same region, and not remains which had been brought in from either more southern or more northern localities, and that, therefore, the climate indicated would be comparable with that of the southern coast of Labrador bordering upon the Gulf of St. Lawrence, at present.[1]

With respect to the Pleistocene deposits in the vicinity of Toronto, Prof. A. P. Coleman has recently drawn attention to the fact also made clear by our tabular presentation, that in the Don valley, and in Scarboro Heights, the deposits were laid down at different times and belong to periods of very different climatic character. This view is supported not only by the flora but by the fauna also, and Prof. Coleman concludes from the evidence thus afforded, that the climate of the Scarboro Heights period must have been similar to that now existing about Lake Superior and in Labrador. He is also inclined to favour the view that the Scarboro beds were laid down first, in which case it would appear that since the Don period the climate of that region has undergone a further change, whereby it is approaching the conditions of the Scarboro period.[2]

So far then, as evidence is at hand, it would seem to indicate that during the Pleistocene period, similar climatic conditions prevailed throughout the region now embracing Scarboro Heights, Green's Creek, Moose River, Montreal; and it is probable that the deposits of these various localities were contemporaneous.

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[1] Can. Nat., N. Ser. III., 74; VI., 406.
[2] Jn'l of Geol. III., 636.